Unit 1: Fitness for Sport and Exercise

Components of fitness

A person is considered to be physically fit if they are able to carry out all of their daily tasks easily and without becoming fatigued. However, being ‘fit for sport’ requires a much higher level of fitness than that needed for activities such as walking the dog or gardening.

Fitness for sport can be broken down into eleven individual components, grouped under two main headings: physical fitness and skill-related fitness. A good level of both physical fitness and skill-related fitness is needed to be successful in most sports, but the relative importance of each component is dependent upon the sport chosen. A component that may be vitally important for one sport may be much less important for another. Elite athletes need a thorough understanding of all the components in order to be successful, so that training sessions can be tailored to their individual needs.

Physical fitness

Aerobic endurance: This is a measure of how efficiently you are able to keep your muscles supplied with nutrients and oxygen while you are exercising. Aerobic endurance is sometimes called cardiorespiratory endurance, aerobic fitness or cardiorespiratory fitness. The cardiorespiratory system is made up of:

• The cardiovascular system: This is responsible for transporting nutrients around the body and removing waste products, such as carbon dioxide, from them. The three main components of this circulatory system are the heart, the blood and the blood vessels.

• The respiratory system: This is responsible for bringing oxygen into the body. It has two main components: the lungs and the airways.

Marathon runners and distance cyclists require a high level of aerobic endurance to be able to keep working over a long period of time in endurance. Your aerobic endurance can be improved by taking part in aerobic training.

Muscular endurance: You have a good level of muscular endurance if your muscles can keep bearing force for a long time. This can mean that they are able to contract many times, for example, when running a marathon, or it can mean that they can sustain one contraction for a long period of time, for example, when pulling in a tug of war. Muscles need a good supply of oxygen (aerobic endurance) and a good supply of energy in the form of glycogen, a type of sugar that is broken down to release energy.

Professional footballers need a high level of muscular endurance to keep them moving around the pitch for 90 minutes. Muscular endurance can be improved by taking part in weight training activities, by running or by regularly performing exercises such as sit-ups and press-ups.

Muscular strength: This is the amount of force, measured in kilograms (kg) or Newtons (N), that can be generated by a muscle when it is contracting. There are lots of different types of strength but the main two are:

• Explosive strength, the amount of force that can be exerted in one quick, powerful contraction, which is useful in sports such as the javelin and the high jump. It is closely linked to power.

• Dynamic strength, the amount of force that can be exerted repeatedly by a muscle, which is useful when completing sit-ups or when cycling. It is closely linked to muscular endurance.

Strength can be increased by taking part in weight training. Smaller weights are lifted many times to improve dynamic strength and heavier weights are lifted fewer times to improve explosive strength.

Flexibility: This is the ability to move all your joints through their full range of movements smoothly. Flexibility is determined by how elastic the ligaments and tendons are at a joint, how strong the muscles are that pull against the joint, and the shape of the bones that form the joint. Most joints are designed to give either strength or flexibility, so the shape of the bones is usually the most important factor in determining flexibility. For example, the shoulder joint is made up of a ball-shaped bone (the end of the humerus) and a cup-shaped bone (the end of the scapula), allowing lots of movement in many directions. Gymnasts have to be flexible so that they can twist their bodies into different shapes when performing routines or vaults.

Flexibility can be improved by taking part in lots of stretching exercises on a regular basis.

Speed: This is how long it takes for an individual or an object to travel a certain distance, and the faster something moves, the greater its speed.

\[
\text{Speed} = \frac{\text{Distance}}{\text{Time}}
\]

For example, when Usain Bolt runs 100 metres in 9.58 seconds, he is running at a speed of:

\[
100 \text{ metres} \div 9.58 \text{ seconds} = 10.44 \text{ m/s}
\]

The three main types of speed are:

• Accelerative speed, the speed with which you start moving faster, which is seen in sprints of up to 30 metres.

• Pure speed, your maximum speed, which is seen in sprints of up to 60 metres.

• Speed endurance, being able to maintain your maximum speed or near your maximum speed for a period of time, which is seen during sprints with short recovery periods in between.

Speed is important in many team sports to help players beat their opponents. For example, netballers need speed so that they can get into spaces more quickly than their opponents and rugby players need speed to be able to beat their opponents to the try-line.

Speed is often said to be something that we are born with, although some improvements can be made by taking part in strength training and sprint training.

Body composition: This is a measure of how much of your body is made up of fat-free mass, of vital organs, and how much is made up of fat. It is important to have a good balance of the two but sports players usually have a greater proportion of muscle. Some sports performers, such as rowers, require a large muscle mass to give them lots of power and strength, but others, such as marathon runners, require a lower muscle mass so that they don’t have to carry ‘extra’ body mass as they are running. Some sports performers, such as sumo wrestlers, even require quite a large mass of body fat to be successful.

Everyone is born with a predisposition to a particular body composition, although small changes can be made by varying your diet and the amount/type of exercise that you take part in. The important thing is to have the correct body composition for your sport.
Skill-related fitness

Agility: Is the ability of a sports player to move and change direction quickly, precisely and under control. For example, a basketball player has to change direction quickly when dribbling and driving towards the basket. Training has little or no effect on improving agility.

Balance: Is the ability to keep the body stable, when still or moving, by keeping the centre of gravity over the base of support. There are two types of balance:
- A static balance is performed when little or no movement takes place – for example, during a headstand.
- A dynamic balance is performed when movement takes place during a balance – for example, during a cartwheel.

An individual’s overall level of balance is not really something that can be trained, although the ability to perform a particular type of balance, such as a headstand, can be improved through practice.

Coordination: Is the ability to move two or more parts of the body at the same time efficiently and accurately, while ensuring a smooth flow of movement. Even simple acts, such as walking, require a degree of coordination, but a much higher level of coordination is required when playing a tennis shot. Again, an individual’s level of coordination cannot be improved through training, although the ability to perform a particular task can be improved through practice.

Power: Is the ability to combine strength with speed and is expressed as the time it takes to perform a task. Power is very closely linked to explosive strength. Power is needed in most sports, although it is more obvious in some. For example, boxers need power to be able to punch hard and fast, while golfers need power in order to hit the ball over a greater distance.

Reaction time: This is the time it takes to respond to a stimulus, such as a ball coming towards you when fielding in cricket. The shorter the amount of time it takes to respond, the quicker the reactions of the performer. Reaction time is incredibly important in events such as the 100 metres because the sprinter who responds fastest to the sound of the gun has a better chance of winning the race. Reaction time cannot be improved through training, although the time taken to respond to a simple stimulus, like the starting gun, can be improved through practice. It is likely, though, that this is more about anticipating the gun than responding to it.

4. For each component of skill-related fitness, name one sport that requires a high level of that component and one sport that requires a low level of that component. For example, reaction time is very important in sprint events but not very important for those competing in a marathon.

5. Choose one sport and rank the components of skill-related fitness, in order, from the most important to the least important. Give an example, from your chosen sport, of each component in action. For example, rowers require a low level of agility because they do not have to change direction very often, other than to move forwards and backwards in a rhythm.

6. Rank the components of skill-related fitness, in order, from the most important to the least important, for each of the following sports performers: a footballer, a cyclist taking part in the Tour de France, and a swimmer in the 50-metre freestyle. Give reasons to justify your rankings.
Determining exercise intensity

In order for training to be effective, it has to be designed so that it is specific to each individual. And, as such, the intensity of the exercises should differ from person to person. What represents considerable aerobic stress for an untrained person will fall well below an elite athlete’s requirements. The simplest method for calculating exercise intensity is to use a performer’s working heart rate.

Maximum Heart Rate (MHR)

Before calculating a working heart rate, it is necessary to first calculate a performer’s MHR, which can be defined as ‘the maximum number of times a person’s heart can contract in one minute’. This is done using one of the following equations:

MHR for men = 220 – age
MHR for women = 226 – age

Therefore a 20-year-old male’s MHR = 220 – 20 = 200 beats per minute (bpm)

Once we have calculated a person’s MHR, we can then use the training pyramid to calculate their working heart rate.

The training pyramid

The training pyramid is a way of calculating how hard you need to train and how long each training session should be. Each section of the pyramid represents a different training zone and the width of the zone represents the amount of time that you need to train in that zone. So, if you are working in the aerobic training zone, the higher the zone, the harder you need to work. The width of the zone represents the amount of time that you need to train in that zone. Therefore a 20-year-old male who wishes to undertake continuous training to improve his cardiovascular health and fitness should work hard enough to make his heart contract between 160bpm and 170bpm in order to train in the aerobic zone. Slower than 120bpm would have little or no training effect and above 170bpm would cause the performer to become fatigued too quickly.

If a 20-year-old male’s MHR = 220 – 20 = 200bpm, then his training zones can be calculated as follows:

- The aerobic zone = 60–85% of 200bpm = 120–170bpm
- The anaerobic zone = 85–95% of 200bpm = 170–190bpm
- The speed zone = 95–100% of 200bpm = 190–200bpm

Therefore, a 20-year-old male who wishes to undertake continuous training to improve his cardiovascular health and fitness should work hard enough to make his heart contract between 120bpm and 170bpm in order to train in the aerobic zone. Slower than 120bpm would have little or no training effect and above 170bpm would cause the performer to become fatigued too quickly.

The Borg Rating of Perceived Exertion Scale

In sports and exercise testing, the Borg Rating of Perceived Exertion Scale, or ‘Borg RPE’, is used to measure exercise intensity by asking a performer to rate their perceived level of exertion. Borg found that there is a direct relationship between how the performer feels, and their heart rate, breathing rate and working oxygen levels. Doctors use the scale to document a patient’s exertion during health tests. Sports coaches use it to assess the intensity at which athletes work during training and competition.

There are a number of Borg RPE scales in existence but the most common is the Fifteen Point Scale:

<table>
<thead>
<tr>
<th>Borg RPE</th>
<th>Description</th>
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<tbody>
<tr>
<td>100% effort: very, very hard intensity</td>
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<tr>
<td>95% effort</td>
<td></td>
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<tr>
<td>90% effort: very hard intensity</td>
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<td>85% effort</td>
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<td>80% effort: hard intensity</td>
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<tr>
<td>75% effort</td>
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<tr>
<td>70% effort: somewhat hard intensity</td>
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<td>65% effort</td>
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<td>60% effort: fairly light intensity</td>
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<td>55% effort</td>
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<td>50% effort: very light intensity</td>
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<td>40% effort</td>
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<td>30% effort: very, very light intensity</td>
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<td>20% effort</td>
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<td>10% effort: very light intensity</td>
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<td>5% effort</td>
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<td>3% effort: somewhat light intensity</td>
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<td>0% effort: light intensity</td>
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<td>1% effort: very light intensity</td>
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<td>0% effort: very, very light intensity</td>
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Borg suggested that there was a direct relationship between a person’s perceived exertion level and their heart rate so that:

RPE Rating of Perceived Exertion × 10 = Heart Rate (HR)

Therefore, a person who perceives themselves to be working at around level 15 on the Borg RPE Fifteen Point Scale is likely to have a heart rate of around 150bpm at the time.
Principles of training

Improving a performer’s fitness levels requires training that adheres to the principles of training. The principles of training can be remembered using the acronym ‘FITT for SPORT followed by some R&R’.

**Frequency**

Frequency refers to the number of times exercise is undertaken each week. It is recommended that each of us should take part in a minimum of 30 minutes of physical activity three times each week, to achieve the minimal level of fitness required to live a healthy life. A top-class sportsperson will have to train a lot more than this to achieve success in their chosen sport.

**Intensity**

Intensity is how hard the exercise is. While it is important for us to exercise at least three times a week, another important factor is the intensity of which we work. It is recommended that – to stay healthy – we must work in our target zone for at least 20 minutes of our minimum 30-minute sessions. When training for cardiovascular fitness our target zone is between 60 to 85 per cent of our MHR, and it is important that we train at this intensity because this is where our fitness will increase. When training for strength our target zone is between 60 to 85 per cent of the maximum weight we can lift.

**Time**

Time refers to how long each exercise session lasts. It is important that we remain in the target zone for a minimum of 20 minutes to see improvements.

**Type**

Type refers to the nature of the exercise that the performer completes. In order to keep training interesting and the performer motivated, it is essential that the type of training is varied, so that the performer does not complete the same activities every training session. For example, a long-distance runner may train on a track, run up and down hills, or train on the road.

**Progressive overload**

Progressive overload is about training at an appropriate intensity and gradually increasing the amount of stress we place on our bodies in order for fitness gains to occur. It means working above our minimum threshold of training (the minimum amount required to make fitness gains) and below our maximum threshold of training, in order to make fitness gains without risking injury. It does not mean training too hard or too much. For example, a sportsperson looking to improve their muscular strength would need to gradually increase the amount of weight they lift in order to encourage the muscles to adapt to lifting heavier weights, therefore, increasing muscle growth.

**Specificity, and individual differences and needs**

Specificity, and individual differences and needs means focusing training on activities relevant to an individual’s sporting goals and needs. To train for a particular sport or event, it is important that we apply appropriate training methods because each sport has its own specific requirements. Training programmes should include all the specific actions and skills that are used in the sport or event, and it is important that they are performed at game or event speed during training. Gymnasts and swimmers need to train differently, as do players of the same sport if they play in different positions.

When we plan a personal exercise programme, it is essential that we take the individual needs of the performer into account, so that they are appropriately challenged. A first-time marathon runner would not benefit from using a training plan designed for an elite marathon runner, for example, because their fitness levels would not be high enough. The less-experienced runner would find the programme too difficult and would risk injuring themselves.

**Reversibility**

Our bodies need to be placed under stress in order to improve. If our bodies are not challenged, any strength, tone, or skill gains that have previously been made will be reversed. Our bodies lose any gains made as a result of training three times faster than the gains were made. It really is ‘use it or lose it’, so it is important not to get injured or become demotivated.

**Adaptation**

By ensuring that you progressively overload your body during training you are encouraging it to adapt to the new stresses being placed upon it and it becomes stronger or faster than it was as a result. Adaptation occurs in the recovery period after a training session.

**Variation**

It is really important to vary a training programme so that you don’t get bored and you continue to enjoy your exercise sessions.

**Rest & Recovery**

Overtraining occurs when the intensity of exercise exceeds the body’s ability to recover. A performer who has overtrained will cease to make progress, and can even begin to lose strength and fitness. Overtraining is a common problem in weight training, but runners and other athletes also experience it. It is important to remember that our bodies require time to rest and recover after exercise, so there is time for adaptation to take place. Even top-class athletes need to build rest and recovery time into their training programmes.

**Bronze**

1. List three ways that the intensity of exercise can be increased.
2. Write a paragraph to explain how fitness levels can be improved using FITT.
3. Write a one-week training programme for a long-distance runner, using the FITT principles as the basis for your plan.

**Silver**

4. Develop a training programme for a top-class sportsperson and a first-time marathon runner, taking their different training needs into account.
5. Different players in the same team sometimes have different fitness requirements. How many sports, other than football, can you think of where two team members have different training needs? How do they do their training needs differ and why?

**Silver**

6. Develop a training programme for an elite marathon runner and a first-time marathon runner, taking their different training needs into account.
Fitness training methods

Fitness training is much more technical than simply going for a jog each day. Each of the components of fitness has to be trained in a different way and different training methods will develop some components more than others. Because all sports require a mixture of the components of fitness and everyone has different needs, participants should take part in a range of training methods.

Preparation for training

Before undertaking any form of training, it is important to consider the safety aspects of the session. This includes being aware of:

- The safe and correct use of any equipment used.
- The safe and correct application of training techniques.
- Undertaking a warm-up before beginning training.
- Performing an appropriate cool-down after training to aid recovery.
- Applying the FITT principles correctly for each training method.
- Ensuring that the method of training is appropriate for the component of fitness you are trying to develop (that you are following the principle of Specificity).

Warming up

Warming up properly improves performance because it prepares the mind and body for the main activity.

There are three phases to a warm-up.

1. Pulse raising: This aims to gradually raise the heart rate and warm up the largest muscle groups to the working rate. More oxygen is also made available to the working muscles, which will improve performance. Activities often include jogging, sideslipping and skipping.

2. Stretching: This aims to lengthen the specific muscles used in the main activity, helping to prevent injury. Most of this should be active stretching, which involves stretching the joints while moving.

3. Joint mobilization: This aims to move the joints into positions appropriate to the main activity, again helping to prevent injury. Activities often include rotation exercises, such as shoulder rotation, when the joint is moved carefully through its full range of movement.

Cooling down

Cooling down after a performance is just as important as warming up, although it is often overlooked by amateur performers. It returns the body to its pre-exercise state.

There are three phases to a cool-down:

1. Pulse lowering: This is a gentle activity that aims to gradually return the pulse rate to its resting rate. Typical activities include gentle jogging or cycling.

2. Static stretching: This aims to remove any lactic acid build-up in the working muscles to prevent stiffness or soreness after exercise.

3. Developmental stretching: Developmental stretches encourage the muscles to lengthen, increasing their flexibility. They can be static stretches or Proprioceptive Neuromuscular Facilitation (PNF) stretches and should be held for at least 30 seconds.

Flexibility training

Flexibility is the range of movement at a joint. Good flexibility and, therefore, a good range of movement at the joints can help prevent muscle injury, especially when it comes to activities that require explosive work, so it is important to all athletes, but some more than others. There are three training methods that improve flexibility: static stretching, ballistic stretching, and PNF stretching.

Static stretching

There are two main types of static stretching: active stretching and passive stretching. Active stretching is the name given to stretches where the performer applies the force that lengthens and stretches the muscle. Passive stretches, which are also referred to as assisted stretches, involve a partner, wall, barre, or other object assisting the performer with the stretch.

It is important that the muscles that will be used most by the performer are stretched. For example, an outfield player in a hockey team might focus their time stretching their hamstrings, quadriceps, and gastrocnemii, whereas the goalkeeper in the same team might spend more time stretching their deltoids and each latissimus dorsi.

This is because the different positions place demands on different muscles.

Ballistic stretching

Ballistic stretching uses the momentum of moving limbs to force muscles beyond their normal range of motion. The fast, jerky movements should be performed on warm muscles, not cold muscles, to reduce the risk of injury. Martial artists will often perform ballistic stretching because the movements mimic the explosive nature of the sport.

PNF stretching

With PNF stretching the performer has help from a partner or uses an immovable object to provide resistance, to push the limb to stretch the joint further than the performer can stretch it on their own. The muscle is held in an isometric contraction, where the length of the muscle doesn’t change during the contraction, for six to ten seconds. The muscle is then relaxed before the partner stretches the muscle further using a passive static stretch. PNF stretches are often used in rehabilitation programmes.

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Free weights
An effective way to improve strength and muscular endurance is to use free weights. Performers wanting to develop strength and power usually prefer free weights, dumbbells and barbells, to resistance machines because they encourage the body to develop its core strength, as the weight load is not as stable or controlled as it is with resistance machines. However, this means good technique is vital, as poor technique often leads to injury. All free-weight exercises should be performed carefully and the body should be worked through a full range of motion in order to develop muscles appropriately. It is often necessary for a ‘spotter’ to be used in order to ensure that no harm comes to the performer lifting the weight.

Each time a performer completes a lifting or moving action they are working against resistance, the amount of force or weight that must be lifted or moved. Each lift is known as one repetition or ‘rep’, and ‘one repetition maximum’ or ‘1RM’ is the maximum weight a person can lift in a single repetition of an exercise. The number of repetitions a performer completes without a rest is called a ‘set’ and there should be a rest period of one to two minutes between each set. Usually, three sets of each exercise are performed.

Varying the resistance, or load, and the number of reps provides different results:
- People who are training to improve their maximum strength should follow a programme that uses low reps and high loads: 90% 1RM or 90% of the maximum weight they can lift for one to six reps. They are producing a single movement against a high resistance.
- People who are training to improve their muscular endurance should use high reps and low loads: 50–60% 1RM for up to 20 reps. They are performing repetitive movements of a muscle or muscle group.
- People who are training to improve their elastic strength should use medium reps and medium loads: 75% 1RM for 12 reps. They are performing movements in very close succession, useful in sports such as gymnastics.

It is important to consider the order of the exercises in an exercise routine. People who wish to develop their strength should focus on exercises that develop their core muscles first, to stabilize the spine and pelvis, and then move on to assistance exercises, working muscles they need to use in their sport or focusing on one body part per training session if they are not training for a specific sport. It is important not to train the same body part in consecutive training sessions. In contrast, people who use free weights as part of a less specific programme, should alternate between upper and lower body exercises, and between push and pull exercises to prevent becoming tired too quickly.

It is very important that performers who use free-weight training rest after each session to give their bodies time to recover. Two days of rest is recommended between sessions in order for the muscles to fully recover, energy reserves to be topped up, and muscle tissue to be regenerated.

Circuit training
Circuit training consists of a series of exercises arranged in order and designed to develop general fitness, physical fitness, and/or skill-related fitness specific to a particular sport, depending on the exercises chosen.

The great advantage of circuit training is that, depending on the exercises chosen, it can be used to develop strength, power, muscular endurance, agility, aerobic endurance, and anaerobic endurance (the ability to work without burning oxygen for an extended period of time). Top-class 800-metre runners can work anaerobically for approximately 90 seconds in a limited time. It can also involve large numbers of participants in a relatively small space, and participants of different fitness levels can train together.

Circuit training involves six to ten different exercises, called stations, which are completed one after another. You perform each exercise for a set period of time before moving on to the next exercise after a brief, timed rest. When you have finished all the exercises you have completed one circuit and there is usually a slightly longer rest period between each circuit. The total number of circuits performed during a training session usually varies from two to six depending on your level of experience and/or your training goals.

To improve a component of fitness it is necessary to ‘overload’, to work harder than your body is used to working normally. Overload is achieved in circuit training by:
- Reducing target times (the time taken to complete a given number of repetitions)
- Reducing rest times (the time between each exercise)
- Increasing exercise resistance (increasing the difficulty of the exercise)
- Increasing repetitions (increasing the number of times the exercise is repeated, possibly in a given time)
- Increasing stations (increasing the number of exercises)
- Increasing circuits (increasing the number of times the circuit is completed)

The key thing to remember when designing a circuit is that the same body part should not be exercised consecutively to avoid fatigue and reduce the risk of injury. For this reason, it is important to alternate between exercises designed to work the upper body and exercises designed to work the lower body.
Aerobic endurance training

Aerobic endurance training requires the sports performer to work for an extended period of time, longer than the actual event for which he or she is training. For example, Paula Radcliffe will often train upwards of four hours at a time, even though her event (the marathon) is usually over in less than two-and-a-half hours. Endurance training should take place largely in the aerobic training zone of the training pyramid and the work-to-rest ratio should be in the region of 3:1. This means that if you work for 30 minutes you should follow it with a ten-minute rest, and then repeat the session again. There are four types of endurance training:

- Continuous training
- Interval training
- Fartlek training
- Circuit training

Continuous training

Continuous training involves performing an activity – such as jogging, swimming, cycling, walking, or rowing – for an extended period of time (usually longer than 30 minutes) without rest. To improve aerobic fitness you should complete three to four sessions of continuous training per week.

Fartlek training

Fartlek training, also known as ‘speed play’, is a form of road running or cross-country running in which the runner, usually running alone, varies their pace significantly during the run. It is usually regarded as an advanced training technique for an experienced runner who has been using interval training to develop speed and to raise their anaerobic threshold. However, the ‘average’ runner can also benefit from a simplified form of fartlek training, to develop self-awareness and to introduce variety into their training programme.

Short, fast runs are alternated with recovery periods of slow running or jogging. The training is continuous with no rest periods. The vast majority of the running takes place in the aerobic zone but the short, fast sprints push the performer to work anaerobically for short periods at a time. Fartlek training takes place on the road or in a park and there is no predetermined schedule to follow. Instead the athlete sets the length of the intervals and their pace in response to how they are feeling. An advantage of fartlek training is that the athlete concentrates on feeling the pace and their physical response to it, thereby developing self-awareness and pace judgement skills. Also, the athlete is free to experiment with changes of pace and endurance as well as intensity by running with weights, a weighted backpack, or a harness, making it an excellent component of a distance runner’s training programme. However, it is primarily a technique for advanced runners because it requires honesty to ensure a demanding workload, and maturity to avoid overdoing the pace or length of the intervals.

Interval training

Interval training consists of alternating intervals of running over a specific distance in a set time (in other words, fast running for anywhere between 30 seconds to five minutes), with recovery periods that are specified in terms of duration, distance, or both and which can consist of complete rest, walking, or light running. Interval training can improve anaerobic endurance when the work period is longer than 20 minutes and the rest period is one third of the work period. The appropriate work period is around 60 per cent of a person’s maximum oxygen uptake – or \( VO_2 \text{ max} \) – which is the volume of oxygen a person consumes while exercising at their maximum capacity. Decreasing the recovery periods and increasing the intensity of the work periods further develops anaerobic endurance. Training sessions will focus on specific race demands.

Interval training is similar to fartlek training, except that it is much more rigid. You decide before the start how long to run for, at what speed, and how long and often your rest periods will be. It is more suitable for the inexperienced athlete, as it does not require the same level of honesty and decision-making as fartlek training.

This type of training is a component of a balanced training programme that will include recovery days and a range of other running activities, depending on the goals of the individual. Mixing interval training with running a range of distances and different types of running (such as cross-country running and hill running) can contribute to overall fitness and the capacity to engage in successful competitive running.

Speed training

Speed training is a way of developing a performer’s speed over short distances. This is useful in almost all sports because speed can often be the difference between winning and losing. For example, footballers need to be able to cover a distance quickly to beat an opponent to the ball and tennis players need to be quick to reach the ball during a rally. Speed training should always be carried out in the speed zone of the training pyramid. It is of a very high intensity, so work periods should be short and frequent, and interspersed with lots of short rest periods. This makes speed training a type of interval training. It is generally accepted that a work-to-rest ratio of 1:6 is desirable. This means that a performer should work at a maximum level for a very short period, usually up to about 15 seconds, and then follow this with a rest period that is six times longer, repeating the sequence several times. There are three types of speed training:

- Hollow sprints
- Acceleration sprints
- Interval training

Hollow sprints

These are similar to interval training, in that a period of work is broken up by a ‘hollow’ period of either rest or lower-level work. A typical hollow sprint session would look something like this:

- 50m Sprint (6–7 seconds)
- 50m Jog (25 seconds)
- 50m Sprint (6–7 seconds)
- 50m Walk (30 seconds)
- 50m Sprint (6–7 seconds)
- 50m Walk (90 seconds)

This is repeated five times before a longer, ten-minute rest period.

Acceleration sprints

Acceleration sprints are a form of anaerobic training where the running speed is increased from jogging to striding and finally to sprinting at maximum pace. Each change of pace usually takes place after 50 metres, and rest periods of jogging or walking take place between each sprint.

As the name suggests, the aim here is to improve acceleration from a static, rolling, or sport-specific starting position. For example, rugby players may start the sprint by lying on the ground to simulate a ruck, whereas footballers may start with their back to the direction of the sprint to simulate turning away from a defender and sprinting into a space. The progressive nature of acceleration sprinting reduces the risk of muscle injury.

Interval training

Interval training can be used to develop speed. The intervals should be shorter and performed at a higher intensity, as close to maximum intensity as possible, than are if interval training is being used to develop aerobic endurance. The number of rest periods and the length of the recovery periods should also be increased to compensate for the shorter and higher intensity intervals.

BRONZE

8. Try to perform each type of aerobic endurance training to see how it feels. Then, suggest a sports performer who would benefit from each type of training and a sports performer who would gain little or no benefit from each type of training.

9. a) Design a training session for a distance runner.
   b) Based on the performer’s ability, suggest ways of altering the session if they were running at school, county, regional, national, and international level.

10. List the benefits of fartlek training for an elite international athlete.
SPOTLIGHT on fitness training methods

1. Create a poster that can be placed in one of your school's sports facilities, which highlights health and safety issues relating to the use of specific equipment in that area.

2. Write a paragraph describing the most appropriate method of training for a sport of your choice.

3. Create a table with the methods of training in the left-hand column and the principles of training in the top row. Fill in each box stating how each principle of training can be applied to each method of training. The table below should start you off.

4. Choose one fitness training method and write a training guide for a friend or family member.

5. Reliability and validity of fitness tests

Check out any fitness test and make a list of the things that you have to do to ensure that the test is reliable and valid.

Carrying out the fitness tests

You need to know the standard, published, method for completing each test and have the necessary equipment to hand. The results of each test must be accurately measured and recorded. A performer's results should then be compared against normative published data, data collected from peers, and against their own previously collected data, and the information analysed and evaluated and used to draw conclusions about the performer's strengths and weaknesses.

Checking the equipment

It is important to check the equipment to make sure that it is safe and working properly. This includes calibrating machines and, where necessary, checking that they are recording data accurately.

Informed consent

It is extremely important to ensure that you have informed consent from all participants who are going to take a test. No one should be asked to undertake a fitness test without first completing a consent form.

Choosing the fitness tests

Different sports place different emphasis on each component of fitness, with a component that is vitally important for one sport being much less important for another. It is, therefore, important to establish which components of fitness are most important for a performer and what the purpose of each fitness test is in order to carry out the appropriate fitness tests.

When deciding which fitness test to perform you should also consider the practicality as well as the advantages and disadvantages of each test. Some fitness tests, such as Bioelectrical Impedance Analysis (BIA), require expensive equipment that you might not have access to. Other tests, such as Bioelectrical Impedance Analysis (BIA), may require you to purchase expensive, specialized equipment, which has been designed specifically for the purpose of carrying out the test. If the test uses cheaper, everyday items, such as a stopwatch and a ruler, it is likely to be less valid.

The validity of a test is much more certain – either the test measures what it is supposed to measure or it doesn't! Perhaps the best example of a test providing results that are not valid is the multistage fitness test. This test has been designed to measure cardiovascular endurance (the ability to use oxygen effectively over a period of time). According to the rules of the test, the higher the level of the test reached, the higher the level of cardiovascular endurance. However, there are two serious flaws with this method:

- The test is supposed to measure cardiovascular endurance but a high degree of agility (to turn quickly each time, power to push off each time, and speed to maintain the required pace between beeps) are also required. For this reason, a swimmer may have a very high level of cardiovascular endurance but not return good results because they aren't a very good runner. The test might, therefore, give invalid results.

- Towards the higher levels of the test, the performer may well be working anaerobically (without oxygen) and, as a result, would get a very high score even though their cardiovascular endurance was surpassed before the end of the test. In this case, the results would again be invalid.

This is not to say that the test should not be used. It does give a good indication of an individual's cardiovascular fitness. It is also cheap to carry out and can be administered to lots of participants at the same time. The key with any fitness test is to understand how useful the results are going to be and to make sure that it is carried out properly, according to the protocols (rules) of the test, to ensure that the results are reliable and valid.

Carrying out the fitness tests

Sports participants should regularly undertake fitness testing so that the effects of their training can be evaluated. After all, there's no point in continuing with a training schedule that is no longer working! But, before carrying out fitness testing, there are a number of pre-test procedures that should be considered.

Reliability and validity of fitness tests

Reliability and validity are two of the major problems with using fitness tests. Reliability refers to the degree to which repeated measurements give the same result, and validity refers to the honesty of the test or – to put it another way – the degree to which the assessment method measures what it is intended to measure.

The reliability of a test is often called into question because the same person gets different results each time they complete it. This can be for a number of reasons:

- Is the test being conducted properly?
- Has the person suffered an injury since they last took the test?
- Is the equipment damaged in any way?
- Is the person using the same amount of effort each time? (Something that it is very difficult to determine.)

The results of a fitness test are more likely to be valid if the test uses expensive, specialized equipment, which has been designed specifically for the purpose of carrying out the test. If the test uses cheaper, everyday items, such as a stopwatch and a ruler, it is likely to be less valid.

When deciding which fitness test to perform you should also consider the practicality as well as the advantages and disadvantages of each test. Some fitness tests, such as Bioelectrical Impedance Analysis (BIA), require expensive equipment that you might not have access to. Other tests, such as Bioelectrical Impedance Analysis (BIA), may require you to purchase expensive, specialized equipment, which has been designed specifically for the purpose of carrying out the test. If the test uses cheaper, everyday items, such as a stopwatch and a ruler, it is likely to be less valid.

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The fitness tests

Over the next few pages you will see a range of tests that can be used to measure an individual's level of fitness. There are also suggested 'normal' or 'normative' results that you would expect from various levels of performer. It should be remembered that these are only some examples of fitness tests and that there are several others that can be used as well. It should also be stressed that the expected results are given only as a guide.

It is important to conduct fitness tests before starting a fitness-training programme. It is also important to use the results to design a suitable programme and have them as baseline data, which can be used to monitor and improve performance. A performer's results can be compared against normative published data, data collected from peers from people of a similar age with similar abilities, and against their own previously collected data. The information can be analysed and evaluated - and used to draw conclusions about the performer's strengths and weaknesses. This knowledge can be used to justify recommendations to a performer about how they can improve their fitness to meet their long-term goals. The results from fitness tests can also be very useful as part of the medium-term goal setting process, lending the weight of authority to suggestions about which fitness training methods are most appropriate.

Flexibility

Sitting and reach test

What do you need?
- A box and a measuring tape or a sit and reach table

How do you do the test?
- Sit comfortably on the floor with your legs straight out in front of you.
- Place the measuring tape, with 0cm level with your feet, parallel with your legs. If you are using a sit and reach table, the measurements are already marked.
- Put the soles of your feet, shoulder width apart, against the box/table.
- Make sure your knees are locked/straight, as this is what determines hamstring flexibility. If your knees bend during the test, the results will be inaccurate.
- With your hands stretched towards your feet, lean forward and reach as far as possible with your fingertips. If possible, reach beyond the end of your toes and over the top of the box.
- Your score. If you don’t make it to your toes then you will get a negative score, showing the distance you were from 0cm.

The sit and reach test can be measured in centimetres or inches.

- There is a lot of normative data to use for comparison.
- It is a well-known test.
- Use a sit and reach table, the measurements are already marked.
- Variations in length of individuals’ arms, legs, and trunk can make comparisons between people misleading.
- The test focuses specifically on the flexibility of the lower back and hamstrings, so does not measure the flexibility of other parts of the body.

Expected level

<table>
<thead>
<tr>
<th></th>
<th>Male footballer</th>
<th>Male gymnast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional</td>
<td>7–10cm</td>
<td>12–15cm</td>
</tr>
<tr>
<td>National</td>
<td>9–13cm</td>
<td>13–17cm</td>
</tr>
<tr>
<td>International/professional</td>
<td>&gt;15cm</td>
<td>&gt;18cm</td>
</tr>
</tbody>
</table>

Average

<table>
<thead>
<tr>
<th>16–19-year-old</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>7–10cm</td>
<td>7–11cm</td>
<td></td>
</tr>
</tbody>
</table>


Advantages of the sit and reach test:
- It is a well known test.
- It is quick and easy to perform.
- There is a lot of normative data to use for comparison.

Disadvantages of the sit and reach test:
- Variations in length of individuals’ arms, legs, and trunk can make comparisons between people misleading.
- The test focuses specifically on the flexibility of the lower back and hamstrings, so does not measure the flexibility of other parts of the body.

Strength

Grip dynamometer

What do you need?
- A grip dynamometer

How do you do the test?
- Use a grip dynamometer to measure grip strength.
- Record the maximum reading from three attempts using the dominant hand.
- Allow a one-minute recovery between each attempt.
- Grip strength can be measured in Kg or KgW, depending on the grip dynamometer used.

Expected level

<table>
<thead>
<tr>
<th></th>
<th>Male footballer</th>
<th>Female footballer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional</td>
<td>&gt;40kg</td>
<td>&gt;28kg</td>
</tr>
<tr>
<td>National</td>
<td>&gt;45kg</td>
<td>&gt;32kg</td>
</tr>
<tr>
<td>International/professional</td>
<td>&gt;50kg</td>
<td>&gt;36kg</td>
</tr>
</tbody>
</table>

Average

<table>
<thead>
<tr>
<th>16–19-year-old</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>30–35kg</td>
<td>22–26kg</td>
<td></td>
</tr>
</tbody>
</table>

Adantages of the grip dynamometer:
- This is a simple test, which is easy to conduct.
- There is a lot of normative data to use for comparison.

Disadvantages of the grip dynamometer:
- The dynamometer must be adjusted for hand size. How well this is done has an effect on the accuracy of the measurement.

Aerobic endurance

VO₂ maximum – or ‘VO₂ max’ – is a measurement of aerobic endurance. It describes the maximum amount of oxygen that the body can use in one minute per kilogram of body weight. It is measured in millilitres per kilogram per minute or ml/kg/min. Fitter people have a higher VO₂ max and can therefore exercise more intensely than people who aren’t as fit.

Multistage fitness test, also known as the ‘bleep test’

What do you need?
- Multistage fitness test CD
- CD player
- Cones
- 15–20-metre marked area

How do you do the test?
- The test involves continuous running between two lines, 15–20m apart, between recorded bleeps (played from the CD).
- The time between the bleeps decreases each minute.
- There are several versions of the test but one commonly used version has an initial running velocity of 8.5km per hour, which increases by 0.5km per hour every minute.
- You must always ensure that you have one foot on or beyond the 15–20-metre marker at the end of each shuffle run.
- If you reach the marker before the next beep, you should wait there until you hear it before resuming running.
- If you do not manage to reach the end of the shuffle run before the beep sounds then you are given two or three more attempts to catch up with the pace before being stopped.

Expected level

<table>
<thead>
<tr>
<th></th>
<th>Female footballer</th>
<th>Female gymnast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional</td>
<td>Level 9</td>
<td>Level 8</td>
</tr>
<tr>
<td>National</td>
<td>Level 10</td>
<td>Level 9</td>
</tr>
<tr>
<td>International/professional</td>
<td>Level 12+</td>
<td>Level 10</td>
</tr>
</tbody>
</table>
Advantages of the multistage fitness test:
- Large groups can perform this test simultaneously.
- The test measures up to maximum capacity, unlike many other tests, which measure endurance.

Disadvantages of the multistage fitness test:
- Practice, motivation, and state of mind can massively influence the score attained.
- The scoring can be subjective.
- If the test is conducted outside, environmental conditions could affect the results.

Forestry step test
This is a variation of a stepping-type fitness test, which is used in the USA.

What do you need?
- Step (40cm for males, 33cm for females)
- Heart-rate monitor
- Metronome
- Published table for calculating maximal aerobic power

How do you do the test?
- Record your body weight in the clothing you will be wearing for the test.
- Set the metronome at 90 beats per minute, to mark out a stepping rate of 22.5 steps per minute.
- Following the stepping rate set by the metronome, step up with the right leg and down with the right leg, then up with the left leg and down with the left leg. This is one step. Continue stepping for five minutes.
- After five minutes of stepping, sit down and measure your heart rate.
- Use your age, post-exercise heart rate, and body weight to calculate the maximal aerobic power using a published table.

Fitness category

<table>
<thead>
<tr>
<th>Age and gender</th>
<th>Superior</th>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-year-old male</td>
<td>57+</td>
<td>56–52</td>
<td>51–47</td>
<td>46–42</td>
<td>41–37</td>
<td>36–32</td>
<td>&lt;32</td>
</tr>
<tr>
<td>20-year-old male</td>
<td>56+</td>
<td>55–51</td>
<td>50–46</td>
<td>45–41</td>
<td>40–36</td>
<td>35–31</td>
<td>&lt;31</td>
</tr>
</tbody>
</table>

Advantages of the forestry step test:
- This simple test requires minimal equipment and is therefore cheap to perform.
- It can be performed inside or outside.
- It is possible to self-administer this test.

Disadvantages of the forestry step test:
- Some people may not have the fitness level or coordination to maintain the required stepping rate.

Speed

35-metre sprint
The objective of this test is to monitor the athlete’s level of sprint fatigue.

What do you need?
- 35-metre marked section in a straight line, preferably on a running track
- Starting blocks
- Stopwatch
- Assistant

How do you do the test?
- Sprint 35 metres from a standing start/sprint start using the blocks.
- Allow a 30-second recovery while walking back to the start.
- Repeat the sprint five times, completing a total of six sprints.
- Record the time for each sprint, which is usually measured in seconds (s).

At the present time, there is no data on expected levels available for this test, although it is generally accepted that a difference of less than 0.8 seconds between the first sprint and the last sprint represents excellent performance.

Advantages of the 35-metre sprint:
- This simple test requires minimal equipment and is therefore cheap to perform.
- It can be performed inside or outside.

Disadvantages of the 35-metre sprint:
- Human error in timekeeping can lead to incorrect or misleading results.

Speed and agility

Illinois agility run test

What do you need?
- Flat, non-slip surface
- 8 cones
- Stopwatch
- Assistant

How do you do the test?
- Set up the course, as shown in the diagram.
- Warm up before beginning the test.
- Lie face down on the floor at the ‘Start’ cone.
- When your assistant gives the command ‘Go’ and starts the stopwatch, jump to your feet and run around the cones in the correct order to the finish.
- Your assistant should stop the stopwatch and record your time when you pass the ‘Finish’ cone.

The following are the national norms for 16 to 19-year-olds:

![Illinois agility run test image]

<table>
<thead>
<tr>
<th>Gender</th>
<th>Below average</th>
<th>Average</th>
<th>Above average</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>18.2–19.3 seconds</td>
<td>16.2–18.1 seconds</td>
<td>15.2–16.1 seconds</td>
<td>&lt; 15.2 seconds</td>
</tr>
<tr>
<td>Female</td>
<td>21.8–23.0 seconds</td>
<td>18.0–21.7 seconds</td>
<td>17.0–17.9 seconds</td>
<td>&lt; 17.0 seconds</td>
</tr>
</tbody>
</table>

(Source: Davis, B. et al., Physical Education and the Study of Sport, Mosby Publishing, 2000)

Advantages of the Illinois agility run test:
- It is cheap and easy to conduct.

Disadvantages of the Illinois agility run test:
- Human error can lead to inaccuracies in timing.
- Weather conditions and the surface can affect the results.
Anaerobic power

Vertical jump test

What do you need?
- Wall
- Measuring tape
- Partner
- Chalk
- Weighing scales

How do you do the test?
- Stand side-on to a wall and reach up with the hand closest to the wall. Stand your feet flat on the ground, with your knees bent at approximately right angles and your feet flat on the ground. Your hands should be resting on your thighs.
- From the starting position, on the command ‘Go’, start the press-up by bending your elbows and lowering your body until the shoulders drop below the level of the elbows. Then return to the starting position. Pausing to rest is permitted only in the starting position.
- Your partner should count how many full press-ups are completed in one minute or up to the point where the performer retires from the test.

Disadvantages of the one-minute press-up test:
- The press-up must be technically correct for it to count, and what makes a technically correct press-up is open to interpretation. This can lead to disputes about the total number.
- The performer will get tired if they stay in the ready position for too long. This can make testing many people simultaneously, difficult.

One-minute sit-up test

What do you need?
- Stopwatch
- Partner

How do you do the test?
- Lie on a carpeted or cushioned floor with your knees bent at approximately right angles and your feet flat on the ground. Your hands should be resting on your thighs.
- Squeeze your stomach, push your lower back flat, and raise your upper body high enough for your hands to slide along your thighs to touch the tops of your knees. Don’t pull with your neck or head, and keep your lower back on the floor. Then return to the starting position.
- Your partner should count how many full sit-ups are completed in one minute or up to the point where the performer retires from the test.

Advantages of the one-minute sit-up test:
- The test is simple to perform.
- It requires minimal equipment.
- Large groups may be tested at once.

Disadvantages of the one-minute sit-up test:
- It is difficult to determine when a correct sit-up has been performed so there may be a dispute about the total number.

Muscular endurance

One-minute press-up test

What do you need?
- Stopwatch
- Partner

How do you do the test?
- Take up the starting position, with your arms straight, elbows locked, body straight, hands placed slightly wider than shoulder-width apart (with fingers pointing forward), and both feet on the floor.
- From the starting position, on the command ‘Go’, start the press-up by bending your elbows and lowering your body until the shoulders drop below the level of the elbows. Then return to the starting position. Pausing to rest is permitted only in the starting position.
- Your partner should count how many full press-ups are completed in one minute or up to the point where the performer retires from the test.

Expected level

<table>
<thead>
<tr>
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<th>Male footballer</th>
<th>Male swimmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional</td>
<td>45 reps per minute</td>
<td>50 reps per minute</td>
</tr>
<tr>
<td>National</td>
<td>55 reps per minute</td>
<td>55 reps per minute</td>
</tr>
<tr>
<td>International/professional</td>
<td>65+ reps per minute</td>
<td>60 reps per minute</td>
</tr>
</tbody>
</table>

Advantages of the one-minute press-up test:
- It is quick and easy to set up.
- No specialist equipment is required.

Disadvantages of the one-minute press-up test:
- The press-up must be technically correct for it to count, and what makes a technically correct press-up is open to interpretation. This can lead to disputes about the total number.
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The Lewis nomogram. (From: E L Fox and D K Mathews: Interval Training: Conditioning for sports and general fitness (Saunders, 1974))
Use a ruler and sharp pencil to join up the two plots. The line you have drawn should be straight and relaxed.

Take a minimum of two measurements at each site and calculate the average of the two readings.

Grasp the skinfold firmly between your thumb and index finger and pull away from the body. The skinfold should be gripped about one centimetre away from the mid point.

Maintaining your grip, place the callipers midway between the base and tip of the skinfold with the dial facing upwards and allow the callipers to release fully so that full tension is placed on the skinfold.

Read the dial of the skinfold callipers to the nearest 0.5mm shortly after you have released the callipers. Continue to grasp the skinfold throughout testing.

Take a minimum of two measurements at each site and calculate the average of the two readings.

Add up the results for each of your three skinfold measurements and work out your percentage body fat result by plotting your age in years and the sum of the three skinfolds on the nomogram.

Use a ruler and sharp pencil to join up the two plots. The line you have drawn will cross the percent body fat scale. Read your percent body fat result to the closest 0.5% according to your gender.

Disadvantages of the Jackson-Pollock nomogram method for prediction of percent body fat:
- It is complicated and will require specialist help.
- It requires specialist equipment.
- Some people may feel uncomfortable stripping down in front of the tester.
- It can be difficult to ensure that the results are valid and reliable if the tester is inexperienced.

Body Mass Index (BMI)

Your BMI provides a way of calculating whether or not your body is of an ideal weight. A BMI test is designed for men and women over the age of 18, and although people under the age of 18 can use it, their results should not be taken to have any significant meaning.

What do you need?
- Weighing scales marked in kilograms
- Measuring tape
- Calculator
- Partner

How do you do the test?
- Measure your height in metres. If you are 182cm (6 feet) in height, you are actually 1.82m.
- Calculate your BMI using this formula below:

\[
BMI = \frac{\text{weight (kg)}}{\text{height (m)} \times \text{height (m)}}
\]

- NHS Direct (UK) provides the following assessment of BMI measurements. If your BMI is:
  - Less than 18.5 kg/m² you are underweight for your height.
  - 18.5 to 24.9 kg/m² you are an ideal weight for your height.
  - 25 to 29.9 kg/m² you are over the ideal weight for your height.
  - 30 to 39.9 kg/m² you are obese.
  - Over 39.9 kg/m² you are very obese.

Advantages of BMI:
- It involves a simple calculation using standard measurements.

Disadvantages of BMI:
- Muscle weights more than fat, so bodybuilders and trained athletes will often have a BMI in excess of 25 kg/m² without being overweight.

Bioelectrical Impedance Analysis (BIA)

Another way to measure body fat is to use BIA, where electrodes are attached to the wrist and the ankle, and an electrical current is passed from one to the other. Body fat restricts the flow of the electric current, so the more current that is needed, the greater the percentage of body fat the person has.

Advantages of BIA:
- The test accurately measures what percentage of your total body weight is made up of bone, muscle, fat, and water.
- It is quick and gives instant results.
- The test can be administered repeatedly over time without adverse effects.

Disadvantages of BIA:
- It requires expensive equipment and technical knowledge.
External Exam Practice

Tackling the exam
You can decide to take the exam when you are ready. It will be completed on a computer and will last for one hour. There are a total of 50 marks available and the number of marks for each question is shown in brackets. Depending on the number of marks you get, you will receive one of the following grades for the unit:

- Distinction at Level 2
- Merit at Level 2
- Pass at Level 2
- Level 1
- Unclassified.

The exam contains different types of questions, and some sample questions for you to practise are provided below.

1. Which of the following is the definition of muscular endurance? (1)
   A. The ability of the muscular system to work efficiently over a period of time.
   B. The maximum force that can be generated by a group of muscles.
   C. The ability of the cardiorespiratory system to work efficiently.
   D. The ability of a performer to run for a long period of time.

2. Power is a combination of two components of fitness. Which is the correct pairing? (1)
   A. Aerobic endurance and flexibility
   B. Speed and body composition
   C. Strength and speed
   D. Strength and aerobic endurance

3. The FITT principle has four elements. Link the element with its description. (4)
   - Frequency: How hard you train
   - Intensity: How long you train for
   - Type: How often you train
   - Time: What you train

4. Laura and her trainer are discussing how critical the components of fitness are to her successful participation as a gymnast.
   Laura tells her trainer that she thinks that good physical and skill-related fitness help her to meet the demands her sport places on her, and help her to reach her optimal performance.
   Explain how flexibility is important for Laura as a gymnast. (2)

5. (a) Steven is 20 years old. What is his Maximum Heart Rate? (1)
   (b) What is Steven’s Training Zone? (2)
   You must show your calculations.

6. Below are incomplete definitions of some of the principles of training. Complete the sentences by entering the principle of training. (6)
   (a) _______________ training should consider the individual’s sport or activity.
   (b) _______________ is how the body reacts when training loads are increased.
   (c) _______________ happens if training stops or the intensity of training is reduced.
   (d) _______________ is important to keep training fresh and exciting.
   (e) Adaptation occurs during _______________.
   (f) _______________ is about keeping training demanding enough to cause the body to adapt.

7. Link each component of fitness with an appropriate fitness test. (8)
   - Body Impedance Analysis (BIA)
   - Illinois agility run test
   - Vertical jump test
   - Sit and reach test
   - Multistage fitness test
   - One-minute press-up test
   - 35-metre sprint
   - Grip dynamometer

8. (a) What type of training session is show in this photograph? (1)
   A. Hollow sprints
   B. Circuit training
   C. Plyometrics
   D. Interval training
   (b) Describe how this method of training helps to improve fitness. (3)

9. (a) Which of the following best describes what is happening at Point D on the graph? (1)
   A. Warming up
   B. Cooling down
   C. Working at a station of the circuit training programme
   D. Resting in between stations of the circuit training programme
   (b) Look at the graph and explain what is happening at each of the points labelled A to E. (5)

10. A person’s working heart rate will always be below their Maximum Heart Rate. Explain this statement. (2)